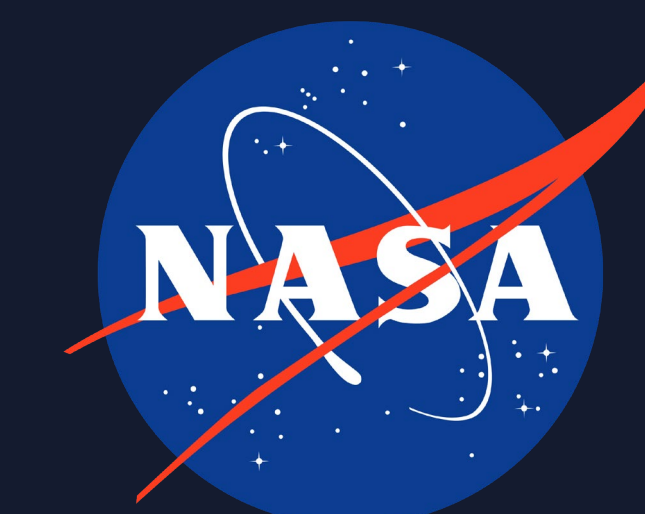


EVALUATING THE RELATIONSHIPS BETWEEN SUPINE PROPRIOCEPTION ASSESSMENTS WITH UPRIGHT FUNCTIONAL MOBILITY AND BALANCE TESTS



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INTRODUCTION

- Sensorimotor adaptations during spaceflight can result in impaired posture and locomotion upon return to Earth [1], [2].
- In-flight sensorimotor countermeasures and assessment tools are needed to mitigate risks associated with mission-critical task performance upon return to Earth or arrival to Mars.
- The tilt board (Fig. 1) is proposed as an inflight proprioceptive countermeasure and will be tested in an upcoming bed rest study [3, 4].
- Proprioceptive assessments on the tilt board may also help predict post-flight and post-bedrest functional task performance

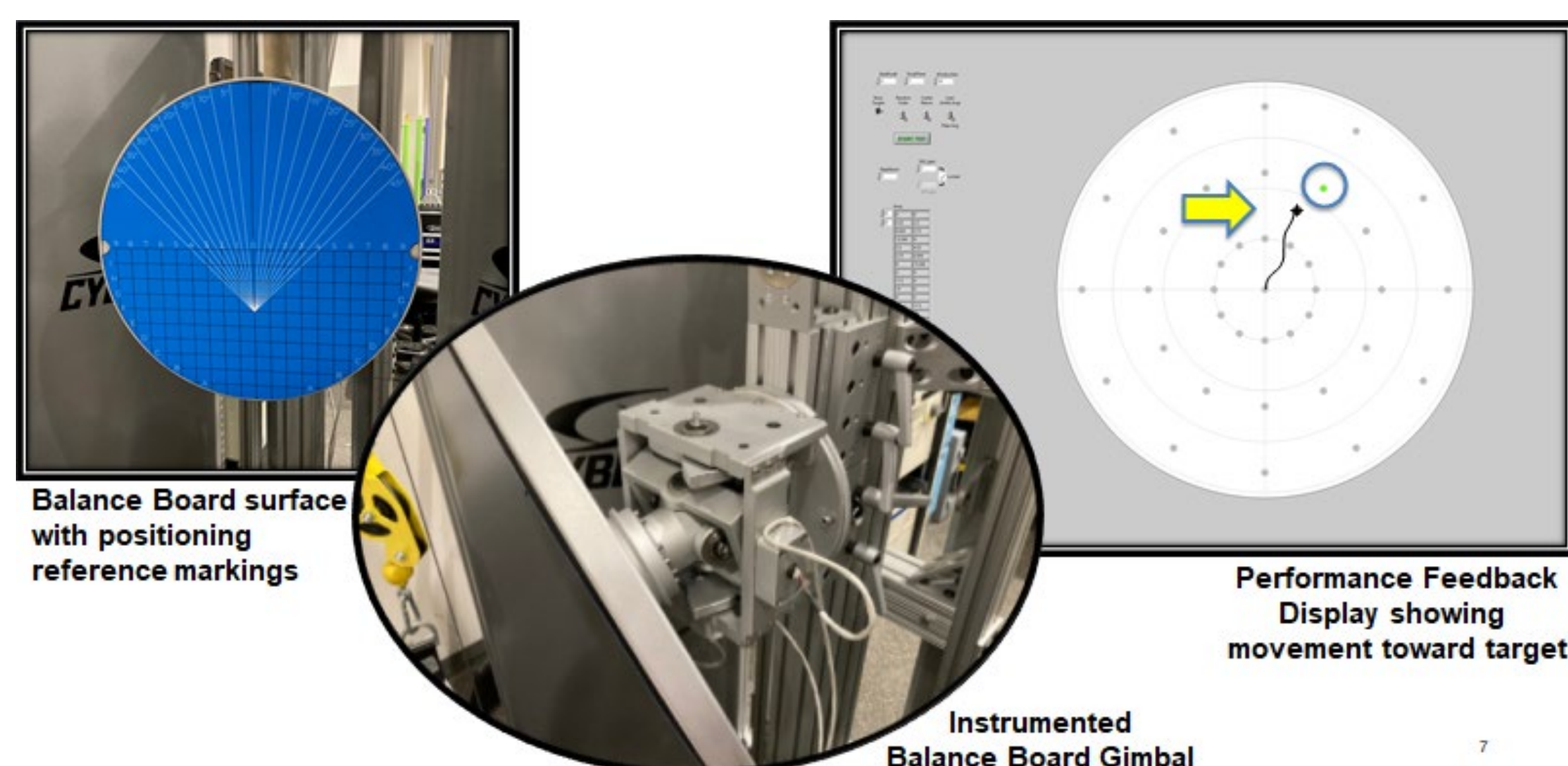


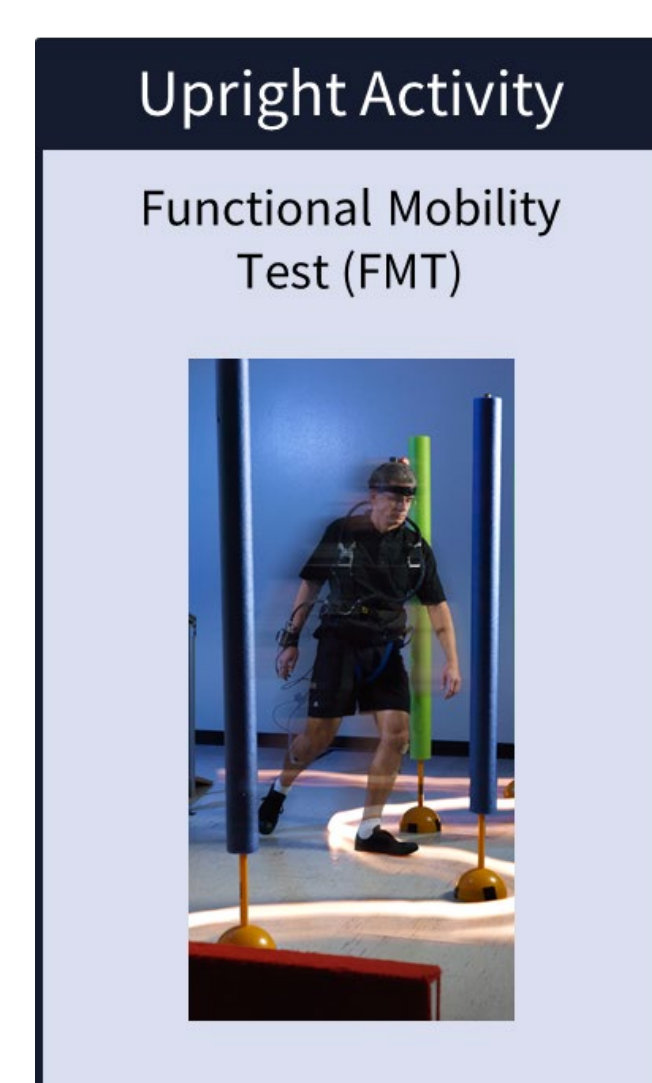
Fig. 1. The Tilt Board is proposed as an inflight proprioceptive countermeasure.

RESEARCH QUESTION

What is the association between supine proprioceptive assessments on the tilt board and upright functional task performance?

METHODS

- Seventeen healthy participants
 - 8 males and 9 females
 - 27.9 ± 8.5 years
 - 7 participants had prior training on the tilt board
- Partially-randomized experiment design to address fatigue effects across these assessments and others in the protocol
- Four proprioception assessments were completed by the participants.
- Two trials were completed for each activity.



Upright Proprioception Assessments

- ▶ Functional mobility task (FMT) [2], [6]
 - Measure completion time for an obstacle course

Fig. 2. One upright proprioception assessment was completed by the participants. The FMT is an obstacle course activity designed to characterize locomotor dysfunction.

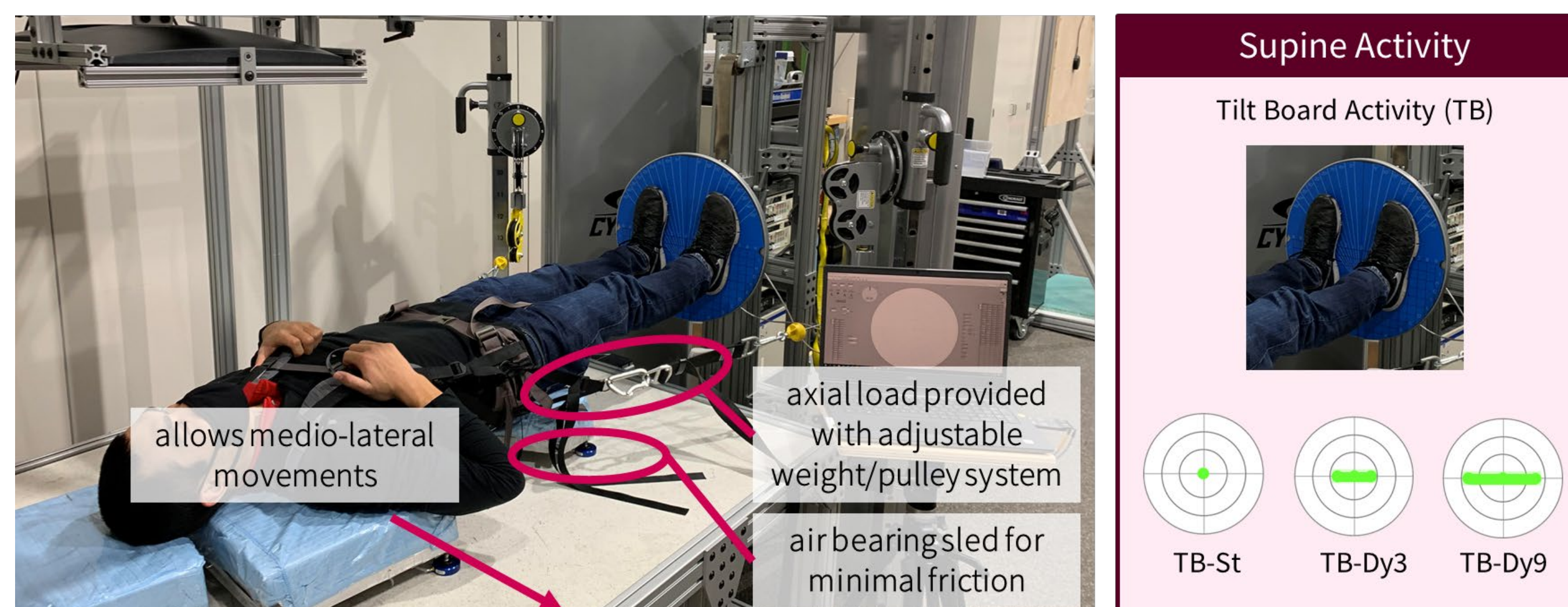


Fig. 3. The Gravity Bed is used to allow a proprioceptive challenge in a supine body orientation [5] and can be used in combination with the tilt board. Three variations of the tilt board activity were included, with green regions indicating the range of possible targets presented by the display screen for each activity type.

Supine Proprioception Assessments

- Participants were positioned supine on an air bearing sled with axial loads pulling them onto the tilt board (Fig. 3) [5].
- ▶ Single-leg static activity on the tilt board (TB-St)
 - 30% bodyweight loading
 - Measure percent time spent on center target over 30-seconds
 - Repeated for each leg
- ▶ Two-feet dynamic activity on the tilt board
 - 60% bodyweight loading
 - Measure the number of targets capture in 30 seconds
 - Targets were placed at mediolateral tilts between 0° and 3° or 0° and 9° for activity variations TB-Dy3 and TB-Dy9, respectively.

RESULTS

- TB-St was the most difficult task, with 4 “falls” and 12 trials that could not be completed successfully due to difficulty starting the task.
- T-tests showed no significant difference between experienced and non-experienced tilt board users, except in TB-Dy9, which showed higher performance ($p < 0.05$) in experienced participants.
- Spearman correlations showed statistically significant, strong correlations between scores for the FMT and each tilt board activity (Fig. 4).
- Spearman correlations on the non-dominant foot in TB-St were not significantly correlated with FMT (Fig. 4).

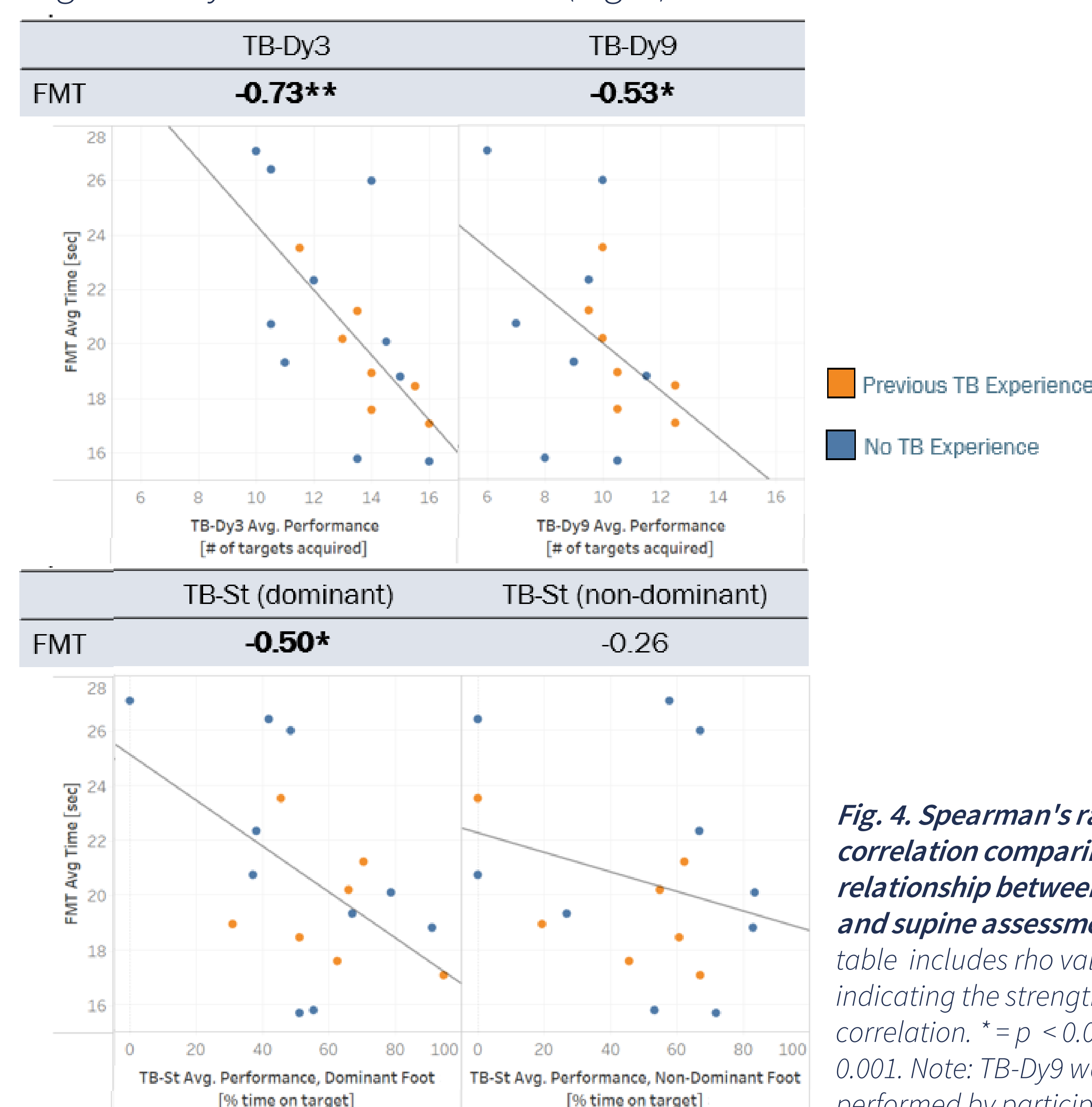


Fig. 4. Spearman's rank-order correlation comparing the relationship between upright and supine assessments. The table includes rho values, indicating the strength of the correlation. * = $p < 0.05$, ** = $p < 0.001$. Note: TB-Dy9 was not performed by participants 1 & 2.

- Static and dynamic tilt board performance were not always correlated (Fig. 5).

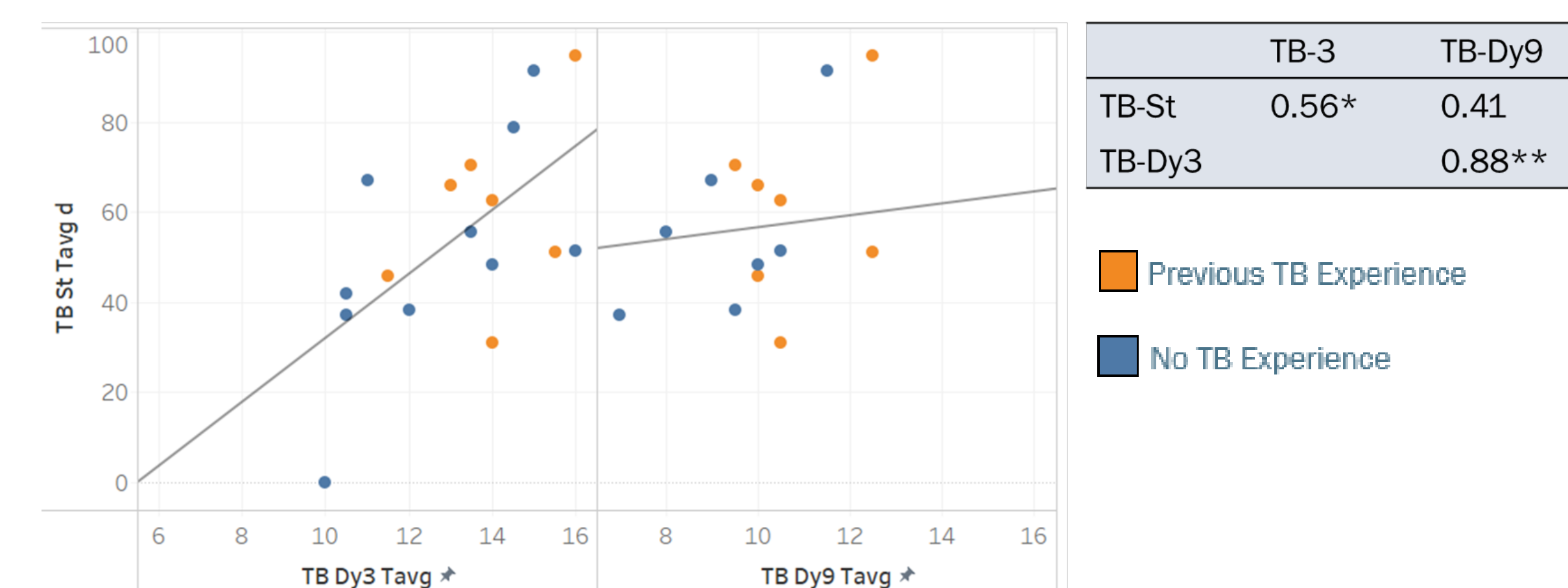


Fig. 5. Spearman's rank-order correlation comparing the relationship between static and dynamic supine assessments. The table includes rho values, indicating the strength of the correlation. * = $p < 0.05$, ** = $p < 0.001$. Note: TB-Dy9 was not performed by participants 1 & 2.

DISCUSSION

- Supine proprioceptive assessments on the tilt board may predict upright performance in an operationally-relevant dynamic task
- The correlation between the tilt board and upright performance in the FMT is promising, as the FMT is a standard post-flight measure designed to characterize locomotor dysfunction [2], [6].
- The dominant foot may be more representative of upright functional performance.
- Dynamic and static assessments may provide different information about sensorimotor performance.
- Limitations: limited # of participants, fatigue effects
- Future Work
 - Comparisons to upright static activity performance (single leg standing)
 - Continued investigation of tilt board training effects and activity configurations

CONCLUSION

- These efforts intend to inform the selection of a sensorimotor assessment method for the upcoming bed rest study.
- Future work aims to continue preparing these capabilities for future in-flight sensorimotor training and assessment to mitigate the risks of proprioception impairment after spaceflight.

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